

REMARKS

Claims 1-17, 21-22 and 27-29 remain presented for examination. Claims 11 and 15 have been amended. Claim 11 has been rewritten in independent form to include the limitations of Claims 1 and 10, and Claim 15 has been amended to correct an informality. No new matter has been added.

Applicants note with appreciation the statement in the Office Action that Claims 11 and 12 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 11 has been amended in independent form, including all of the limitations of Claims 1 and 10. Claim 12 depends from Claim 11. Applicants therefore submit that Claims 11 and 12 are now in condition for allowance.

Election of Species

In the most recent Office Action Summary mailed April 21, 2004, it is stated that Claims 17, 21 and 22 are withdrawn from consideration. Applicants respectfully submit that these claims should not have been withdrawn from consideration, for the following reasons.

In the previous Office Action mailed January 15, 2004, election of one of the following two species was required: a first embodiment represented by Figures 2(a)-2(i), and a second embodiment represented by Figures 3(a)-3(e). Election of one of these two species was required for prosecution on the merits, to which the claims would be restricted if no generic claim is finally held to be allowable.

In response to this election of species requirement, Applicants elected the first embodiment, represented by Figures 2(a)-2(i). Claims 5-7 and 29 read on the first (elected) embodiment, and Claims 17 and 21-22 read on the second (non-elected) embodiment.

Notably, Claims 1-4, 8-16 and 27-28 are generic. That is, each of Claims 5-7 and 29 (the elected species), and Claims 17 and 21-22 (the non-elected species)

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depend from generic Claim 1. A final decision has not yet been made with regard to the allowability of this generic claim. Applicants therefore respectfully submit that the claims should not yet have been restricted to the elected species, and claims directed to the non-elected species should not yet have been withdrawn from consideration. 37 CFR 1.146.

Claim Objections

Claim 15 is objected to because of the following informality: In line 2 of the claim, "for" should be replaced with -to- for grammatical correctness.

In response, Claim 15 has been amended in accordance with this suggestion. Applicants therefore submit that this objection to Claim 15 has been overcome.

Rejection of Claims 1-4, 8-10, 14, 27 and 29 under 35 U.S.C. 102(b) over Schrems et al.

Claims 1-4, 8-10, 14, 27 and 29 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 6,200,873 to Schrems et al. Applicants respectfully traverse this rejection.

Claim 1 is directed to a method for forming a buried plate in a trench capacitor. After the trench is formed, it is a feature of the present invention that the trench is partially filled with a dopant source material to form a dopant source having a top surface below a top of the trench, the dopant source material containing at least one dopant. Applicants respectfully submit that this feature (at least) is not disclosed by Schrems et al., as follows.

The Schrems et al. patent is directed to a method for producing a trench capacitor. One embodiment is shown in Figures 10a-e. First a trench 108 is formed, then a dopant-containing layer 177 is deposited on the sidewalls of the trench (col. 11, line 66 – col. 12, line 4). Notably, dopant-containing material 177 is deposited as a

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layer, with a thickness typically of 5 to 30 nm (col. 12, lines 1-2). The trench is not partially filled with dopant-containing material 177.

The Schrems et al. method continues with a sacrificial polysilicon 152 being deposited in the trench (col. 12, lines 12-14). The trench is partially filled with this polysilicon material 152, but Schrems et al. teach that this material is preferably not doped and is therefore not a dopant source material (col. 12, lines 14-17).

Schrems et al. therefore fail to disclose a method wherein the trench is partially filled with a dopant source material. Accordingly, Applicants respectfully submit that Claim 1 is not anticipated by the Schrems et al. patent. Claims 2-4, 8-10, 14, 27 and 29, which depend ultimately from Claim 1, are also not anticipated by the Schrems et al. patent. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 5-7 under 35 U.S.C. 103(a) over Schrems et al. in view of Mei

Claims 5-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schrems et al. in view of U.S. Patent No. 6,232,171 to Mei. Applicants respectfully traverse this rejection.

Claim 5-7 depend ultimately from Claim 1. As discussed previously, it is a feature of the invention defined by Claim 1 that the trench is partially filled with a dopant source material. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Schrems et al. in view of Mei, as follows.

As discussed previously, Figures 10a-b of the Schrems et al. patent disclose a method in which a dopant layer 177 is first deposited on sidewalls of the trench, and then the trench is partially filled with an undoped sacrificial polysilicon material 152. Schrems et al. fail to disclose or even suggest a method wherein the trench is partially filled with a dopant source material.

Mei fails to remedy the deficiencies of the Schrems et al. disclosure. The Mei patent is directed to a method for forming a bottle-shaped deep trench. Mei discloses that a filler oxide layer 160 is deposited to partially fill the trench, to aid in subsequent formation of a nitride collar at the top of the trench. This filler oxide layer,

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however, is not doped. Moreover, Mei fails to disclose the deposition of any dopant source material into the trench. Mei therefore fails to provide any motivation to modify the teaching of Schrems et al.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Schrems et al. in view of Mei. Claims 5-7, which depend from Claim 1, are also patentable over Schrems et al. in view of Mei. Applicants therefore request withdrawal of this rejection.

Rejection of Claim 13 under 35 U.S.C. 103(a) over Schrems et al. in view of Tsai et al.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schrems et al. in view of U.S. Patent No. 6,706,587 to Tsai et al. Applicants respectfully traverse this rejection.

Claim 13 depends from Claim 1. As discussed previously, it is a feature of the invention defined by Claim 1 that the trench is partially filled with a dopant source material. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Schrems et al. in view of Tsai et al., as follows.

As discussed previously, Figures 10a-b of the Schrems et al. patent disclose a method in which a dopant layer 177 is first deposited on sidewalls of the trench, and then the trench is partially filled with an updoped sacrificial polysilicon material 152. Schrems et al. fail to disclose or even suggest a method wherein the trench is partially filled with a dopant source material.

Tsai et al. fail to remedy the deficiencies of the Schrems et al. disclosure. The Tsai et al. patent is directed to a method for forming buried plates in trench. The buried plates are formed by depositing a doped hemispherical silicon grain (HSG) layer 290 as shown in Figure 2e, and then performing drive-ins on the HSG layer 290 to cause As ions in the HSG layer to diffuse out to the sidewalls of the bottle trench (col. 3, lines 30-33 and 43-47). The HSG layer 290 is deposited as a layer; the trench is not filled, partially or otherwise, with any dopant source material. Tsai et al. therefore fail to provide any motivation to modify the teaching of Schrems et al.

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Accordingly, Applicants respectfully submit that Claim 1 is patentable over Schrems et al. in view of Tsai et al. Claim 13, which depends from Claim 1, is also patentable over Schrems et al. in view of Tsai et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 15 and 16 under 35 U.S.C. 103(a) over Schrems et al. in view of Kudelka et al.

Claims 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schrems et al. in view of U.S. Patent Appl. 2001/0016398 by Kudelka et al. Applicants respectfully traverse this rejection.

Claims 15 and 16 depend from Claim 1. As discussed previously, it is a feature of the invention defined by Claim 1 that the trench is partially filled with a dopant source material. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Schrems et al. in view of Kudelka et al., as follows.

As discussed previously, Figures 10a-b of the Schrems et al. patent disclose a method in which a dopant layer 177 is first deposited on sidewalls of the trench, and then the trench is partially filled with an undoped sacrificial polysilicon material 152. Schrems et al. fail to disclose or even suggest a method wherein the trench is partially filled with a dopant source material.

Kudelka et al. fail to remedy the deficiencies of the Schrems et al. disclosure. The Kudelka et al. application is directed to a method for forming a bottle shaped trench. Kudelka et al. teach that a buried plate may be formed prior to or after the expansion of the trench (¶ 0037). In one embodiment shown in Figures 2-4, the trench 110 is lined with ASG layer 111, the trench is filled with resist 103, ASG layer 111 and resist 103 are then etched back, resist 103 is removed, and buried plate 112 is annealed to drive dopants into substrate 102 from ASG layer 112 (¶ 0037-0038). In another embodiment shown in Figures 5-6, the trench is lined with ASG/TEOS stack 105 and nitride liner 107, the trench is filled with resist 121, resist 121 is etched back along with stack 105 and nitride 107, and buried plate 112 is formed by oxidizing

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(¶ 0040-0041). In a third embodiment shown in Figure 12, buried plate 112 is formed by a gas doping process wherein dopants are provided in a gaseous form which absorb onto an exposed surface of substrate 102 and diffuse into the substrate to form buried plate 112.

In the first two embodiments of Kudelka et al. the dopant source material is deposited in the trench as a layer, and in the third embodiment the dopant source material is in a gaseous form. None of the Kudelka et al. embodiments includes partially filling the trench with a dopant source material. The only material which fills or partially fills the trench is an undoped resist material. Kudelka et al. therefore fail to provide any motivation to modify the teaching of Schrems et al.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Schrems et al. in view of Kudelka et al. Claims 15 and 16, which depend from Claim 1, are also patentable over Schrems et al. in view of Kudelka et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claim 28 under 35 U.S.C. 103(a) over Schrems et al. and Tsai et al. in view of Bronner et al.

Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schrems et al. and Tsai et al. in view of U.S. Patent No. 6,177,696 to Bronner et al. Applicants respectfully traverse this rejection.

Claim 28 depends ultimately from Claim 1. As discussed previously, it is a feature of the invention defined by Claim 1 that the trench is partially filled with a dopant source material. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Schrems et al. and Tsai et al. in view of Bronner et al., as follows.

As discussed previously, Figures 10a-b of the Schrems et al. patent disclose a method in which a dopant layer 177 is first deposited on sidewalls of the trench, and then the trench is partially filled with an undoped sacrificial polysilicon

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material 152. Schrems et al. fail to disclose or even suggest a method wherein the trench is partially filled with a dopant source material.

Tsai et al. similarly disclose a method for forming buried plates, by depositing a doped hemispherical silicon grain (HSG) layer 290 and then preforming drive-ins on the HSG layer. Notable, the HSG layer 290 is deposited as a layer; the trench is not filled, partially or otherwise, with any dopant source material. Tsai et al. therefore also fail to disclose or even suggest a method wherein the trench is partially filled with a dopant source material.

Bronner et al. fail to remedy the deficiencies of the Schrems et al. and Tsai et al. disclosures. The Bronner et al. patent is directed to another method of forming a capacitor plate. The dopant source material in this method is an ASG film 7, formed on sidewalls of the trench as shown in Figure 2 (col. 4, lines 46-49). The trench is then partially filled with photoresist film 11 as shown in Figure 2, and ASG film 7 is recessed and resist film 11 is removed as shown in Figure 3 (col. 4, line 59 – col. 5, line 15). After deposition of TEOS film 12 as shown in Figure 4, buried plate 14 is formed in Figure 5 by annealing (col. 5, lines 16-40). Again, the dopant source material is an ASG film or layer. The only material which fills or partially fills the trench is an undoped resist material. Bronner et al. therefore fail to provide any motivation to modify the teaching of either Schrems et al. or Tsai et al.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Schrems et al. and Tsai et al. in view of Bronner et al. Claim 28, which depends from Claim 1, is also patentable over Schrems et al. and Tsai et al. in view of Bronner et al. Applicants therefore request withdrawal of this rejection.

Conclusion

To summarize, in each of the cited references which disclose a dopant source material, the dopant source material is deposited in the trench as a layer. In contrast to the prior art, the dopant source material of the present invention partially fills the trench to a level below a top surface of the trench. Applicants therefore respectfully


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submit that the present application is patentable over each of the cited references, and is now in condition for allowance. If the Examiner has any questions or believes further discussion will aid examination and advance prosecution of the application, a telephone call to the undersigned is invited.

No fee is believed to be due for the submission of this amendment and response. If any fees are required, however, the Commissioner is authorized to charge such fees to Deposit Account No. 09-0458.

Respectfully Submitted,



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